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Braun, Ueli ; Gerspach, Christian ; Reif, C ; Hilbe, Monika ; Nuss, Karl

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# Clinical, laboratory and ultrasonographic findings in 94 cows with type-1 abomasal ulcer

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## Summary

This study included 94 cows aged 2.1 to 12.0 years ( $5.2 \pm 2.05$  years) that were examined at a referral clinic because of type-1 abomasal ulcer. The most common clinical findings were poor general health status (94%), partial or complete anorexia (93%), congested scleral vessels (89%), decreased skin surface temperature (76%), decreased or absent faecal output (72%), abdominal guarding (59%), tachypnoea (56%), rumen atony (53%) and positive percussion and simultaneous auscultation and/or ballottement and simultaneous auscultation on the right side (53%). The most common laboratory findings were hypokalaemia (68%), positive base excess (60%) and azotaemia (51%). The chloride concentration of rumen fluid was increased in 48% of the cows. The diagnosis of type-1 ulcer was made during laparotomy and/or postmortem examination. One or more concurrent diseases were diagnosed in 97% of the cows. Seventy-eight (83%) cows were euthanased immediately after the initial examination, during laparotomy or after unsuccessful treatment, and eight (8.5%) cows died, and all were examined postmortem. Eight (8.5%) cows were discharged and six of these made a complete recovery.

**Key words:** abomasum, cattle, type-1 ulcer

## Klinische, labordiagnostische und sonographische Befunde bei 94 Kühen mit Labmagenulkus Typ 1

Die vorliegende Untersuchung umfasst 94 Kühe im Alter von 2.1 bis 12.0 Jahren ( $5.2 \pm 2.05$  Jahre), die wegen eines Labmagenulkus Typ 1 untersucht wurden. Die häufigsten klinischen Befunde waren in abnehmender Reihenfolge gestörtes Allgemeinbefinden (94%), stark reduzierte bis aufgehobene Fresslust (93%), injizierte Skleralgefäße (89%), kühle Körperoberfläche (76%), reduzierte oder fehlende Kotmenge (72%), gespannte Bauchdecke (59%), Tachypnoe (56%), Pansenatonie (53%) und positive Perkussions- und/oder Schwingauskultation rechts (53%). Als häufigste abnorme Blutbefunde wurden Hypokaliämie (68%), positive Basenabweichung (60%) und Azotämie (51%) festgestellt. Die Chloridkonzentration im Pansensaft war bei 48% erhöht. Die Diagnose eines U1 erfolgte bei der Laparotomie und/oder der pathologisch-anatomischen Untersuchung. Bei 97% der Kühe wurden eine, zwei oder mehr weitere Krankheiten diagnostiziert. Von den 94 untersuchten Kühen wurden 86 (91%) unmittelbar nach der Eintrittsuntersuchung, während der Laparotomie oder nach einem erfolglosen Therapieversuch euthanasiert und seziert. Acht Kühe (9%) wurden erfolgreich behandelt und gesund nach Hause entlassen. Sechs Kühe erholten sich vollständig.

**Schlüsselwörter:** Labmagen, Rind, Ulkus Typ 1

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## Introduction

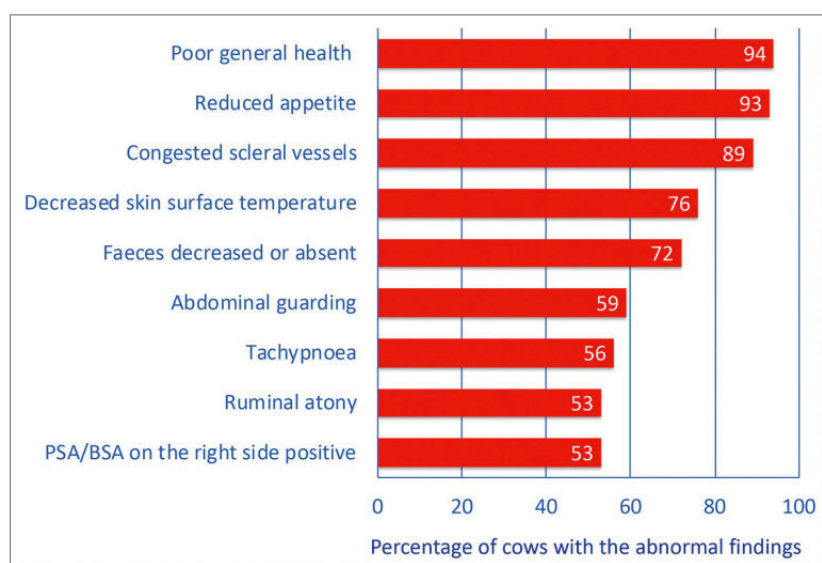
Abomasal ulcers in cattle are divided into several types<sup>8,16,19,32,35</sup> and occasionally more than one ulcer type occurs in a cow.<sup>18</sup> Type 1 (U1) is a non-perforated ulcer associated with minimal haemorrhage, and type 2 (U2) is characterised by massive intraluminal haemorrhage. Type 3 (U3) and type 4 (U4) ulcers are both perforated ulcers associated with either localised peritonitis (U3) or diffuse peritonitis (U4). The term type 5 ulcer (U5) was introduced to describe an ulcer that has perforated into the omental bursa.<sup>15</sup> Clinical and laboratory findings were recently described in 87 cows with U4,<sup>11</sup> 145 cows with U2,<sup>12</sup> 60 cows with U3,<sup>13</sup> and 14 cows with U5.<sup>15</sup> Based on observations in 912 slaughtered cows, type 1 ulcers were further classified into four subtypes 1a to 1d.<sup>6</sup> Minimal mucosal defects were classified as subtype 1a, deep erosions with localised haemorrhage as subtype 1b and crater-shaped ulcers as subtype 1c. Subtype 1d comprised 2 ulcer manifestations, those with stellar folds that converged to a central point from different directions, and those characterised by perforated mucosal folds.<sup>6</sup> Subtypes 1a and 1c occurred in the pyloric region in more than 70% of cases, and subtypes 1b and 1d were seen predominantly in the fundus region.<sup>6</sup> This classification into four subtypes was recently adopted by other authors;<sup>25</sup> of 1,327 cows examined at an abattoir, 84% had type-1 abomasal ulcers, and as previously described,<sup>6</sup> subtypes 1a and 1c were seen predominantly in the pyloric region and subtypes 1b and 1d predominantly in the fundic region. In another study, type-1 ulcers were seen in the pylorus in 11 (69%) of 16 affected cows post-mortem.<sup>21</sup> The prevalence

of U1 was 20.5% in a study involving 912 cows at an abattoir<sup>6</sup> and 48.5% in a study of 33 slaughtered cows.<sup>21</sup> Older studies reported prevalences ranging from 1.0 to 9.1%.<sup>3,20,32</sup> Type-1 abomasal ulcers are commonly associated with septic diseases<sup>8</sup> but tend to be clinically inapparent in the absence of concurrent disease. Type-1 ulcer may manifest as non-specific indigestion characterised by fluctuations in appetite, moderate tympany, colic and dark, often soft to liquid faeces.<sup>8</sup> There may be transient or intermittent melena and some cows have anaemia. Based on a study of 1,317 cows investigated at slaughter, it was concluded that type-1 abomasal ulcers do not have a relevant impact on milk yield, carcass weight or reproductive performance.<sup>26</sup> The aetiology of abomasal ulcers has been described in detail.<sup>22,23</sup> A diagnosis of U1 usually necessitates postmortem examination but occasionally is possible when focal thinning of the abomasal wall can be palpated during laparotomy. Abomasal ulcer should be suspected in cows with a poor appetite in the first weeks after calving when correction of a possible underlying disorder such as displaced abomasum does not have the expected result.<sup>8</sup> Faecal occult blood test kits were shown to produce unsatisfactory results and were therefore considered unsuitable for the diagnosis of type-1 abomasal ulcer, most likely because of mild and intermittent haemorrhage.<sup>21</sup> Measurement of gastrin and pepsinogen levels in blood has not become part of the routine diagnostic procedure in cattle suspected of having an abomasal ulcer.<sup>22,23</sup> Likewise, endoscopic and ultrasonographic examination of the abomasum has been found to be unsuitable diagnostically.<sup>22,23</sup> Ultrasound-guided abomasocentesis is an additional diagnostic procedure in cows, and the detection of blood in the aspirate makes a diagnosis of abomasal ulcer highly likely.<sup>7</sup> The goal of the present study was to describe the findings in 94 cows with U1 to aid veterinarians in the diagnosis of this condition.

## Materials and Methods

### Cows

This was a retrospective study of 94 cows that had a main diagnosis of U1. The cows had been admitted to the Veterinary Teaching Hospital, University of Zurich, from January 1, 1991 to December 31, 2014. The final diagnosis of U1 was based on the results of laparotomy and/or postmortem examination. The results were described in detail in a dissertation.<sup>29</sup> The cows ranged in age from 2.1 to 12.0 years (mean  $\pm$  sd = 5.2  $\pm$  2.05 years). Breeds included Brown Swiss (37), Swiss Fleckvieh (33) and Holstein-Friesian (24). The duration of illness was < 2 days in 25 cows, 2 to 6 days in 30 cows, 7 to 14 days in 15 cows and > 14 days in 18 cows. In 6 cows the duration of illness was not recorded. Forty-seven (50%) cows had calved within 4 weeks of becoming ill,



**Fig. 1:** Most common abnormal clinical findings in 94 cows with type-1 abomasal ulcer. PSA/BSA = Percussion and simultaneous auscultation and/or ballottement and simultaneous auscultation.

**Table 1:** Clinical findings in cows with type-1 abomasal ulcer

Variable	Finding	Number of cattle	%
Heart rate (bpm) (n=94, median=80 bpm)	Normal (60 – 80)	45	48
	Decreased (54 – 59)	3	3
	Mildly increased (81 – 100)	23	25
	Severely increased (121 – 160)	23	25
Respiratory rate (breaths per min.) (n=94, median=28 breaths per min.)	Normal (16 – 25)	38	40
	Decreased (12 – 15)	3	3
	Mildly increased (26 – 35)	26	27
	Moderately increased (36 – 45)	14	15
Rectal temperature (°C) (n=93, median=38.9 °C)	Normal (38.4 – 38.9)	41	44
	Decreased (36.1 – 38.3)	11	12
	Mildly increased (39.0 – 39.4)	30	32
	Moderately increased (39.5 – 40.0)	8	9
Rumen motility (n=94)	Severely increased (40.1 – 42.2)	3	3
	Normal	6	7
	Decreased	34	36
	Absent	50	53
Foreign body tests (n=80)	Hypermotility	4	4
	All negative	61	76
	Back grip positive <sup>1</sup>	18	22
	Pole test positive <sup>1</sup>	14	17
PSA and BSA on the left side (n=94)	Percussion of the reticulum positive <sup>1</sup>	6	7
	At least one test positive	19	24
	Both negative (normal)	81	86
	Only PSA auscultation positive	6	6
PSA and BSA on the right side (n=94)	Both (BSA and PSA) positive	7	8
	Both negative (normal)	44	47
	Only PSA positive	12	13
	Only BSA positive	10	10
Faeces (n=94)	Both (PSA and BSA) positive	28	30
	Amount of faeces decreased	52	55
	No faeces in the rectum	14	15
	Faeces watery to loose	18	23
Rectal findings (n=93)	Faeces dark to black	14	18
	Normal findings	50	54
	Rumen dilated	20	22
	Small intestines dilated	4	4
Rectal findings (n=93)	Loss of negative pressure	3	3
	Crepitus	1	1
	Various findings	15	16

<sup>1</sup>Positive: at least 3 of 4 attempts elicited a grunt  
 PSA Percussion and simultaneous auscultation  
 BSA Ballottement and simultaneous auscultation

13 (14%) cows were 2 to 4 months and 11 (12%) were ≥ 5 months postpartum. Sixteen (17%) cows were dry, and the reproductive status of the remaining 7 (7%) cows was not known.

### Clinical examination and laboratory analyses

The cows underwent a thorough clinical examination as described previously.<sup>11</sup> Blood samples were collected for the determination of haematocrit, total leukocyte count, concentrations of total protein, fibrinogen, urea, potassium and chloride, and for the glutaraldehyde clotting test and venous blood gas analysis. A urine sample was analysed in 91 cows using a test strip (Combur<sup>9</sup>, Roche, Basel) and a refractometer to measure specific gravity. A sample of rumen fluid was collected from 80

cows using a Dirksen probe and assessed for colour, odour, consistency and pH (data not shown). In addition, the methylene blue reduction time and the concentration of chloride were determined.

### Ultrasonographic and radiographic examinations

Seventy-nine cows underwent ultrasonographic examination of the right side of the abdomen (n=68) and the reticulum (n=42).<sup>9</sup> Lateral radiographic views of the reticulum were taken in 31 cows.<sup>10</sup>

### Diagnosis of type-1 abomasal ulcer

A diagnosis of U1 was made when an ulcer could be palpated during laparotomy or was detected during post-mortem examination. Cows in which the U1 was ac-

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accompanied by a U2, U3, U4 or U5 were excluded from the study.

### Statistical analysis

The program IBM SPSS Statistics 22.0 was used for analysis. Frequencies were determined for each variable. The Wilk-Shapiro test was used to test the data for normality. Means  $\pm$  standard deviations were calculated for normal data (haematocrit, total protein, potassium, pH, pCO<sub>2</sub>, urine pH) and medians for non-normal data (heart rate, respiratory rate, rectal temperature, leukocyte count, fibrinogen, urea, chloride, glutaraldehyde test time, HCO<sub>3</sub><sup>-</sup> and base excess of venous blood, urine specific gravity). A value of  $P < 0.05$  was considered significant.

## Results

Overall, the clinical, laboratory and ultrasonographic findings were more likely to be attributable to the wide range of concurrent diseases than to type-1 abomasal ulcers *per se*.

### Clinical findings

The most common clinical findings were, in decreasing order of frequency, an obtunded demeanour (94%), partial or complete anorexia (93%), congested scleral vessels (89%), reduced skin surface temperature (76%), decreased or no faecal output (72%), abdominal guarding (59%), tachypnoea (56%), rumen atony (53%) and

**Table 2:** Haematological and blood biochemical findings in cows with type-1 abomasal ulcer

Variable (mean $\pm$ sd or median)	Finding	Number of cattle	Percent
Haematocrit (%) (n=94, mean $\pm$ sd=35 $\pm$ 5.7 %)	Normal (30 – 35)	33	35
	Decreased (23 – 29)	19	20
	Increased (36 – 49)	42	45
Leukocyte count (/ $\mu$ l) (n=94, median=7,800/ $\mu$ l)	Normal (5,000 – 10,000)	58	62
	Decreased (1,700 – 4,999)	12	13
	Increased (10,001 – 49,000)	24	25
Total protein concentration (g/l) (n=94, mean $\pm$ sd=79 $\pm$ 11.5 g/l)	Normal (60 – 80)	56	60
	Decreased (40 – 59)	2	2
	Increased (81 – 106)	36	38
Fibrinogen concentration (g/l) (n=93, median=6.0 g/l)	Normal (4 – 7)	59	63
	Decreased (1 – 3)	7	8
	Increased (8 – 15)	27	29
Urea concentration (mmol/l) (n=94, median=6.6 mmol/l)	Normal (1.8 – 6.5)	46	49
	Increased (6.6 – 35.4)	48	51
Potassium concentration (mmol/l) (n=94, mean $\pm$ sd=3.6 $\pm$ 0.8 mmol/l)	Normal (4.0 – 5.0)	27	29
	Decreased (1.6 – 3.9)	64	68
	Increased (5.1 – 6.4)	3	3
Chloride concentration (mmol/l) (n=94, median=100 mmol/l)	Normal (95 – 105)	40	42
	Decreased (69 – 94)	26	28
	Increased (106 – 116)	28	30
Glutaraldehyde test (min.) (n=88, median=10.0 min.)	Normal (10 – 15)	57	65
	6.1 to 9.9 min.	8	9
	3.1 to 6.0 min.	8	9
	$\leq$ 3 min.	12	14
	Prolonged (16 – 20)	3	3

**Table 3:** Venous blood gas analysis in 88 cows with type-1 abomasal ulcer

Variable (median or mean $\pm$ sd)	Finding	Number of cattle	Percent
Base excess (mmol/l) (median=3.4 mmol/l)	Normal (-2 – +2)	19	22
	Decreased (-11.3 – -2.1)	16	18
	Increased (2.1 – 24.6)	53	60
pCO <sub>2</sub> (mmHg) (mean $\pm$ sd=45.9 $\pm$ 7.6 mmHg)	Normal (35 – 45)	38	43
	Decreased (27.6 – 34.9)	4	5
	Increased (45.1 – 61.2)	46	52
HCO <sub>3</sub> (mmol/l) (median=27 mmol/l)	Normal (20.0 – 30.0)	53	60
	Decreased (14 – 19.9)	7	8
	Increased (30.1 – 47.0)	28	32
pH (mean $\pm$ sd=7.41 $\pm$ 0.01)	Normal (7.41 – 7.45)	21	24
	Decreased (7.22 – 7.40)	42	48
	Increased (7.46 – 7.53)	25	28

**Table 4:** Ultrasonographic findings in cows with type-1 abomasal ulcer

Location	Findings	Number of cows	Percent
Reticulum (n=42)	Free fluid in reticular region	8	19
	Echogenic changes with or without fluid inclusions	6	14
	Amplitude of contraction decreased	5	12
	Contour abnormal	2	5
	Atony	2	5
	Elevated from ventral abdominal wall	1	2
Abomasum (n=43)	Right displacement	15	35
	Left displacement	6	14
	Dilated	11	26
Abdomen (n=68)	Intestinal motility reduced	12	18
	Intestinal motility absent	5	7
	Dilated small intestinal loops	8	12
	Intestinal wall thickened	3	4
	Free fluid	2	3

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positive percussion and simultaneous auscultation (PSA) and/or ballottement and simultaneous auscultation (BSA) on the right side (53%) (Fig. 1). In addition to abdominal guarding, the most prominent manifestations of pain were bruxism (15%), an arched back (12%), spontaneous grunting (11%) and muscle tremors (11%). The abdomen was enlarged in 23% of cows and signs of colic including restlessness and shifting weight in the hind limbs, a sunken back and kicking with the hind legs were seen in 21% of the cows. Of the foreign body tests, the back grip was positive in 22%, the pole test in 17% and pain percussion over the area of the reticulum in 7% of the cows (Table 1). All three tests were negative in 76% and at least one test was positive in 24% of the cows. Faecal consistency varied from liquid to normal to dryer than normal. The faeces were thin and paste-like to liquid in 23% and dark to black in 18% of the cows. Recumbency (8%), droopy ears (4%) and abducted elbows (2%) were seen in a few cows. Transrectal examination showed abnormal findings in 43 (46%) of 93 cows including a dilated rumen in 22%, dilated loops of small intestines in 4%, a partial lack of negative intraabdominal pressure in 3% and crepitus in 1% of the cows. Other abnormal transrectal findings including caecal dilatation or a dorsal gas cap with right-sided displacement of the abomasum were recorded in 16% of the cows.

### Laboratory findings (blood, urine, rumen fluid)

The most frequent haematological and biochemical abnormalities were, in decreasing order, hypokalaemia (68%), positive base excess (60%) and azotaemia (51%) (Tables 2 and 3). Haemoconcentration occurred in 45%, hypoproteinaemia in 38%, hyperfibrinogenaemia in 29% and leukocytosis in 25% of the cows. Urinalysis showed haematuria in 38 (42%) of 91 cows with macroscopically normal urine (5 to 250 erythrocytes per high-power field), aciduria (pH≤6.5; overall median pH=8.0) in 34%, glucosuria (0.5 to 10.0 g glucose/l) in

23%, ketonuria (0.1 to 1.5 g ketone bodies/l) in 17% and proteinuria (1.0 to 1.5 g protein/l) in 1% of the cows. The urine specific gravity was decreased (1.000 to 1.019) in 30 (36%) of 84 cows and increased (1.042 to 1.050; overall mean  $1.022 \pm 11$ ) in 5 (6%) cows. The chloride concentration of rumen fluid was increased (26 to 79 mmol chloride/l; overall mean=25 mmol/l) in 38 (48%) of 80 cows.

### Ultrasonographic and radiographic findings

Overall, the ultrasonographic and radiographic findings were non-specific and did not provide evidence of an abomasal ulcer. Ultrasonographic examination showed free fluid in the reticular area in 8 (19%) and echogenic changes with or without fluid inclusions in 6 (14%) of 42 cows (Table 4). The amplitude of reticular contractions was decreased in 5 (12%) of the cows. Two cows had an abnormal reticular contour, two had reticular atony and in one cow, the reticulum was elevated from the ventral abdominal wall. Ultrasonographic examination showed right displaced abomasum in 15 (35%), left displaced abomasum in 6 (14%) and abomasal dilatation in 11 (26%) of 43 cows; this was confirmed clinically, during surgery or during postmortem examination. Small intestinal motility was reduced in 12 (18%) and completely absent in 5 (7%) of 68 cows. The small intestines were dilated (diameter > 3.5 cm) in 8 (12%) cows, the wall thickness was increased in 3 (4%) cows and in 2 (3%) cows, fluid was seen between loops of small intestine.

The radiographic examination showed no abnormalities of the reticulum.

### Treatment, outcome and euthanasia

Seventy-eight (83%) cows were euthanased after the initial examination (n=16), during exploratory laparotomy (n=7) or after unsuccessful treatment (n=61) using pentobarbital (80 mg/kg body weight intravenously; Esconarkon®, Streuli Pharma, Uznach). Two cows died



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immediately after the initial examination and six died during treatment (8.5%). A decision to euthanase was made when the prognosis was guarded based on clinical signs or the presence of concomitant disorders, or when a cow failed to respond to treatment. Eight (8.5%) cows recovered and were discharged, but the recovery was incomplete in two. A diagnosis of U1 was made in these

cows in the authors' clinic during right-flank laparotomy for the treatment of left displaced abomasum.

Treatment was aimed at correcting the main clinical problem that had led to referral and included omentopexy in cows with displaced abomasum and the administration of antibiotics in cows with mastitis or bronchopneumonia. Treatment also included intravenous administration of a solution containing 50 g glucose and 9 g sodium chloride per litre via an indwelling jugular vein catheter for one or more days. Pain medication included flunixin meglumine (1 mg/kg, Flunixin<sup>®</sup>, Biokema, Crissier) for one to three days or metamizole (35 mg/kg, Vetalgin<sup>®</sup>, MSD Animal Health, Luzern) for one to six days, both administered intravenously. Cows with hypocalcaemia (calcium < 2.0 mmol/l), hypophosphataemia (inorganic phosphorus < 1.3 mmol/l), hypokalaemia (potassium < 4.0 mmol/l) and/or hypomagnesaemia (magnesium < 0.8 mmol/l) were treated orally with monocalcium phosphate, sodium dihydrogen phosphate, potassium chloride and/or magnesium oxide. Several cows received one to four 3-litre doses of fresh rumen fluid from a healthy donor cow. All cows underwent daily clinical examination during hospitalisation.



**Fig. 2:** Type-1 abomasal ulcers in a 2.2-year-old beef cow. The cow had been down for 3 days after delivery of a dead calf with dystocia and was referred because she did not respond to aggressive medical treatment. The cow was off feed, had rumen atony and bruxism and the general health status was moderately impaired. Clinical examination on admission showed sacral fracture and the cow was euthanased. Postmortem examination showed two type-1 abomasal ulcers, hyperaemia of the abomasal mucosa and thickening of the abomasal folds.



**Fig. 3:** Multiple type-1 abomasal ulcers in an 8.5-year-old Fleckvieh cow. The cow was 3 months pregnant and had been treated 7 days ago with enrofloxacin, metamizole and dexamethasone for toxic mastitis caused by *E. coli*. The affected quarter largely normalised, but the health status of the cows was severely compromised with anorexia, bruxism, rumen atony, no faeces in the rectum and lameness caused by sole ulcers. The chloride concentration of rumen fluid was increased at 49 mmol/l. The cow was euthanased, and postmortem examination showed multiple crater-shaped type-1 abomasal ulcers. *Mucor* hyphae were seen in histological sections of the abomasal mucosa.

### Postmortem findings of the abomasum

Eighty-five cows underwent postmortem examination and all had one to several type-1c abomasal ulcers (Figs. 2 to 5). Other ulcer types were not seen.

### Diagnosis

A definitive diagnosis of U1 could not be made based on clinical, laboratory, ultrasonographic and radiographic findings. In the eight (8.5%) cows that were discharged, a diagnosis of U1 was made during laparotomy based on palpation or visual inspection of the abomasal wall. In the remaining 86 (91.5%) cows, a diagnosis of U1 was made during postmortem examination. All but three cows had one (n=39), two (n=29) or more (n=23) concurrent diseases in addition to a U1. The most common disorders were left and right displaced abomasum (n=27), vagal syndrome (n=26) and fatty liver syndrome (n=19), and other diseases included mastitis/toxic mastitis (n=12), fascioliasis (n=10), bronchopneumonia (n=7), gastrointestinal parasites (n=7), endometritis/metritis (n=7), lameness (n=6), dicrocoeliosis (n=5), caecal dilatation (n=4), liver abscess (n=4), ketosis (n=3), ileus (n=2) and other conditions (n=32).

### Discussion

In contrast to U2, which is characterised by gastrointestinal haemorrhage and anaemia, both of which are directly linked to the ulcer,<sup>12,22,23,27,32</sup> cows with U1 do



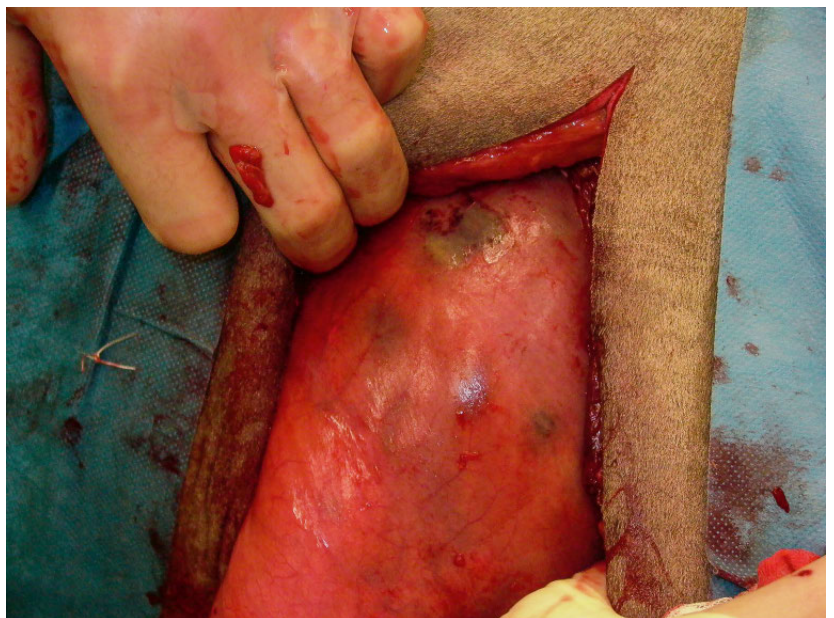
not have ulcer-specific clinical signs; rather, the clinical picture depends on the respective concurrent disease. The most common diseases were left and right displaced abomasum, vagal syndrome and fatty liver syndrome. The causal relationship between U1 and concurrent disease is not clear. We suspect that in cows with displaced abomasum and vagal syndrome, the ulcer was the primary problem that caused the concomitant disorders because of abomasal atony and painful pyloric stenosis, respectively. Likewise, an ulcer could lead to anorexia and subsequent lipomobilisation. However, it is conceivable that U1 results from fatty liver syndrome via endogenous stress related to the liver disease. Endogenous and exogenous stress factors are associated with increased secretion of cortisol, hydrochloric acid and pepsin and decreased release of prostaglandin-E and thus are linked to the pathogenesis of abomasal ulcers.<sup>22</sup> It is also possible that U1 is a secondary event in cows with fascioliasis, mastitis, bronchopneumonia or other conditions.

The clinical findings of cows with U1 were nonspecific with the exception of dark faeces, which were suggestive of abomasal ulcer. Instead, the clinical signs varied with the predominant concurrent disease. Positive PSA and/or BSA suggested left or right displaced abomasum, and a positive response to foreign body tests pointed to intra-abdominal pain. Rumen atony was seen in 53% of all cows and is a typical sign of many severe diseases such as toxic mastitis.<sup>5</sup> Of interest, complete rumen atony was considerably less common in cows with traumatic reticuloperitonitis (6%)<sup>34</sup> than in cows with toxic mastitis (48%)<sup>5</sup> or U4 (73%).<sup>11</sup> The heart and respiratory rates were normal, decreased or increased and thus were not diagnostic for U1. Dark faeces occurred in 18% of the cows and suggested an abomasal ulcer provided that ileus and haemorrhagic bowel syndrome could be ruled out. The differential diagnosis for melena also includes abomasal torsion, abomasal leukosis, intestinal ulcers and tumours, haemorrhagic enteritis, intestinal haemorrhage attributable to coagulation disorders and extra-intestinal haemorrhage;<sup>8,22</sup> however, these conditions are usually accompanied by other clinical manifestations such as colic or diarrhoea.

Similar to the clinical signs, the laboratory findings were not diagnostic for U1. The most common abnormality was hypokalaemia, which was seen in 68% of cows with U1, compared with 72 to 81% of cows with U2, U3 and U4.<sup>11,12,13</sup> Hypokalaemia reflects anorexia because forage is the main source of potassium<sup>30</sup> but is also a typical finding in cows with abomasal reflux syndrome. Based on the increased chloride concentration of rumen fluid, reflux occurred in 48% of the cows, compared with 10% in clinically healthy slaughtered cows with U1.<sup>6</sup> The positive base excess in 60%, haemoconcentra-



**Fig. 4:** Type-1 abomasal ulcer of the pylorus in a 2.7-year-old Brown Swiss cow. The cow had calved 3 weeks previously without problems but had undergone multiple treatments for indigestion and ketosis using ketoprofen and dexamethasone. The clinical appearance of the cow suggested anterior functional stenosis (failure of omasal transport) based on severe abdominal dilatation, which was accompanied by rumen tympany and severely compromised faecal output. The chloride concentration of rumen fluid was decreased at 14 mmol/l, which is a common finding in cows with anterior functional stenosis. Postmortem examination showed a pyloric type-1 abomasal ulcer with a diameter of 2.5 cm and multiple smaller ulcers in the fundic region. The only other lesion was enlargement of the rumen, and pain associated with the pyloric ulcer was believed to have caused the anterior stenosis.



**Fig. 5:** Abomasal ulceration in a 10-year-old Brown Swiss cow. The cow had calved one week previously with light assistance and subsequently had responded to treatment for periparturient paresis. She had also been treated with glucose infusions, dexamethasone and other drugs for ketosis and metritis. The cow became anorexic, and right displaced abomasum was diagnosed one day before referral. The diagnosis was confirmed during laparotomy. Multiple dark irregular lesions of varying size were seen at the serosal aspect of the abomasum, which were considered to be type-1 ulcers, and the cow was euthanased and examined postmortem. A perforated type-4 ulcer was seen in addition to multiple type-1 ulcers; the clinical and laboratory findings of this cow were not included in this study because of the presence of the U4.



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tion in 45% and azotaemia in 51% of the cows of the present study may also have been related to abomasal reflux syndrome. The most common conditions causing reflux syndrome were displaced abomasum and pyloric stenosis (vaginal indigestion); 13 of 26 cows with the latter condition had increased chloride concentrations of between 26 and 66 mmol/l in rumen fluid. A decreased haematocrit typical of anaemia was seen in only 20% of the cows compared with 32% of clinically healthy slaughtered cows with U1, which had a haematocrit lower than 28%.<sup>6</sup> Eighty-two percent of cows with U2 had anaemia<sup>12</sup> compared with 13% of cows with U4;<sup>11</sup> U2 is characterised by haemorrhage and U4 by haemoconcentration. Gastrointestinal haemorrhage such as abomasal ulcer should always be considered in cows with anaemia provided that gastrointestinal parasites and chronic illness can be ruled out.

Only eight of the 94 cows were discharged and the remaining 86 were euthanased or died. However, it is important to remember that sodium chloride/glucose infusion, electrolytes and rumen fluid are inadequate treatments for abomasal ulcer. Specific causal treatment would require drugs to reduce the secretion of hydrochloric acid and pepsin in the abomasum. In human medicine, reduction of gastric acid secretion constitutes the cornerstone of gastric ulcer treatment combined with treatment against *Helicobacter pylori* and discontinuation of NSAIDs.<sup>24</sup> Likewise, reduction of gastric acid secretion is also the fundamental component of gastric ulcer treatment in the dog<sup>17</sup> and horse.<sup>36</sup> Treatment options include H<sub>2</sub>-receptor antagonists, such as cimetidine, ranitidine and famotidine, or proton pump inhibitors such as omeprazole.<sup>17,23</sup> Sucralfate, a gastrointestinal protectant that binds to proteinaceous exudates

found at ulcer sites, is also used in dogs and horses for the oral treatment of gastric ulcers.<sup>17,36</sup> The intravenous administration of the H<sub>2</sub>-receptor antagonist famotidine was shown to be efficacious in increasing the pH of abomasal outflow digesta in adult cattle<sup>4</sup> as was the intramuscular administration of ranitidine.<sup>33</sup> The oral administration of cimetidine and ranitidine in healthy milk-fed calves resulted in immediate increase in abomasal pH in a dose-dependent fashion similar to the oral administration of ranitidine.<sup>1,2</sup> It appears likely that the oral administration of drugs used to block or decrease gastric acid production are contraindicated in adult cattle because of potential inactivation by the rumen flora. However, it appears curious from a veterinary standpoint that proton pump inhibitors are not approved for use in cattle even though they have been shown to be highly efficacious in dogs<sup>31</sup> and horses.<sup>28</sup> These drugs have a short half-life (cimetidine about 1 hour and omeprazole less than an hour in human patients), and it would make sense to investigate injectable forms of cimetidine or omeprazole for the treatment of cattle with abomasal ulcer.

## Conclusions

There are no pathognomonic clinical or laboratory findings in cows with type-1 abomasal ulcer; instead, a tentative diagnosis of U1 can be made in early-lactation cows with a disorder such as displaced abomasum that fails to respond to routine treatment. Specific drugs that are used in other animals to reduce the production and secretion of gastric acid and are approved for use in cattle, would be desirable.

## Résultats cliniques, de laboratoire et échographiques chez 94 vaches atteintes d'un ulcère de la caillette de type 1

La présente étude a inclus 94 vaches âgées de 2,1 à 12,0 ans ( $5,2 \pm 2,05$  ans) qui ont été examinées dans une clinique de référence en raison d'un ulcère de la caillette de type 1. Les signes cliniques les plus courants étaient un mauvais état de santé général (94%), une anorexie partielle ou complète (93%), des vaisseaux scléreux congestionnés (89%), une diminution de la température de la surface de la peau (76%), une diminution ou une absence de débit fécal (72%), une défense abdominale (59%), de la tachypnée (56%), une atonie du rumen (53%) et une percussion positive avec auscultation simultanée (PSA) et / ou ballottement et auscultation simultanée (BSA) du côté droit (53%). Les résultats de

## Risultati clinici, di laboratorio e ultrasonografici di 94 bovini affetti da ulcera abomasale di tipo 1

Questo studio comprende 94 bovini di età compresa tra i 2.1 e i 12.0 anni ( $5.2 \pm 2.05$  anni) affetti da ulcera abomasale di tipo 1 esaminati in una clinica di riferimento. I più comuni risultati clinici rilevavano di un povero stato di salute (94%), anoressia parziale o completa (93%), vasi sclerali congestionati (89%), diminuzione della temperatura superficiale della pelle (76%), diminuzione o assenza di feci (72%), rigida parete addominale (59%), tachipnea (56%), atonia del rumine (53%) e/o una positiva percussione e auscultazione simultanea (PSA) e/o ballottamento e auscultazione simultanea (BSA) a destra (53%). Il risultato di laboratorio più comune era ipopotassiemia (68%), eccesso di basi positive (60%) e azotemia (51%). La concentrazione cloridrica del

laboratoire les plus courants étaient l'hypokaliémie (68%), l'excès de base positif (60%) et l'azotémie (51%). La concentration en chlorure du liquide du rumen a augmenté chez 48% des vaches. Le diagnostic d'ulcère de type 1 a été posé lors de la laparotomie et/ou de l'autopsie. Une ou plusieurs maladies concomitantes ont été diagnostiquées chez 97% des vaches. Soixante-dix-huit vaches (83%) ont été euthanasiées immédiatement après l'examen initial, pendant la laparotomie ou après un traitement infructueux, et huit vaches (8,5%) sont mortes. Toutes ont été examinées post-mortem. Huit vaches (8,5%) sont sorties de clinique et six d'entre elles ont complètement récupéré.

**Mots-clés:** caillette, bovin, ulcère de type 1

liquido ruminale era aumentata nel 48% dei bovini. La diagnosi di ulcera dei tipo 1 è stata fatta durante la laparotomia e/o un esame post mortem. Una o più malattie concomitanti sono state diagnosticate nel 97% dei bovini. Settantotto (83%) bovini sono stati eutanasiati immediatamente dopo il primo esame, durante la laparotomia o dopo un tentativo terapeutico senza successo e 8 (8.5%) dei bovini sono morti e sono stati esaminati post mortem. Otto (8.5%) dei bovini sono stati dimessi e sei di questi si sono ristabiliti completamente.

**Parole chiavi:** abomaso, bovino, ulcera di tipo 1

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